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Washington, DC 20231

OFGS File No. : P/1805-15
Inventor : Mika VALKONEN et al
Title : METHOD FOR SYNCHRONISING IMAGE DATA OBTAINED FROM PROCESS MONITORING CAMERAS
Assignee : Hildeco Oy Ltd

Enclosed herewith please find the following documents in the above-identified application for United States Letters Patent:

8 Pages of Specification including Abstract and Claims
16 Numbered Claims Calculated as 16 Claims for Fee Purposes
2 Sheets of Drawing Containing Figures 1 to 2.
X Declaration and Power of Attorney
X Priority is Claimed under 35 U.S.C. §119:
Convention Date March 1, 1999 for Finland Appln. S.N. 990428
_____ Certified Priority Application
X Preliminary Amendment
X Assignment
X Return-Addressed Post Card
OFGS Check No. 92004, which includes the fee of $730.00, calculated as follows:

Basic Filing Fee:	$ 690.00
Additional Filing Fees:	
Total Number of Claims in Excess of 20, times $18:	
Number of Independent Claims in Excess of 3, times $78: . .	
One or More Multiple Dependent Claims: Total $260.	
Total Filing Fees or	690.00
Total Filing Fee Reduced 50% for Small Entity:	
Assignment Recording Fee: $40	40.00
TOTAL Filing Fee and Assignment Recording Fee:	$ 730.00

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February 29, 2000
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Respectfully submitted,

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P/1805-15

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	New York, New York
Mika VALKONEN et al	Date: February 29, 2000
Serial No.:	Group Art Unit:
Filed:	Examiner:

For: METHOD FOR SYNCHRONISING IMAGE DATA OBTAINED FROM PROCESS MONITORING CAMERAS

Hon. Commissioner of Patents
and Trademarks
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Sir:

Prior to examination, please amend the application as follows:

IN THE CLAIMS:

Please amend claims 3-5 as follows.

Claim 3, line 1, delete "or 2".

Claim 4, line 1, change "any of the claims 1 to 3" to --claim 1--.

Claim 5, line 1, change "any of the claims 1 to 4" to --claim 1--.

Please add the following new claims 6-16.

--6. A method as claimed in claim 2, characterised in that the process is paper manufacture and the object being monitored is the paper web running in the paper machine.

7. A method as claimed in claim 2, characterised in that camera-specific image data is analysed and image variation data based on the level of variation in a plurality of sequential images is compiled, and the image variation graph corresponding to the image variation data of images preceding and following the image to be analysed is displayed on the screen.

8. A method as claimed in claim 3, characterised in that camera-specific image data is analysed and image variation data based on the level of variation in a plurality of sequential images is compiled, and the image variation graph corresponding to the image variation data of images preceding and following the image to be analysed is displayed on the screen.

9. A method as claimed in claim 6, characterised in that camera-specific image data is analysed and image variation data based on the level of variation in a plurality of sequential images is compiled, and the image variation graph corresponding to the image variation data of images preceding and following the image to be analysed is displayed on the screen.

10. A method as claimed in claim 2, characterised in that the output levels of the image variation data of the different camera positions are standardised so as to be mutually comparable, the standardised image variation levels of the different camera positions are compared, and the image data $(2d_1 - 2d_n)$ of the camera position representing the highest-level variation is selected for automatic display.

11. A method as claimed in claim 3, characterised in that the output levels of the image variation data of the different camera positions are standardised so as to be mutually comparable, the standardised image variation levels of the different camera positions are compared, and the image data

$(2d_1 - 2d_n)$ of the camera position representing the highest-level variation is selected for automatic display.

12. A method as claimed in claim 6, characterised in that the output levels of the image variation data of the different camera positions are standardised so as to be mutually comparable, the standardised image variation levels of the different camera positions are compared, and the image data $(2d_1 - 2d_n)$ of the camera position representing the highest-level variation is selected for automatic display.

13. A method as claimed in claim 4, characterised in that the output levels of the image variation data of the different camera positions are standardised so as to be mutually comparable, the standardised image variation levels of the different camera positions are compared, and the image data $(2d_1 - 2d_n)$ of the camera position representing the highest-level variation is selected for automatic display.

14. A method as claimed in claim 7, characterised in that the output levels of the image variation data of the different camera positions are standardised so as to be mutually comparable, the standardised image variation levels of the different camera positions are compared, and the image data $(2d_1 - 2d_n)$ of the camera position representing the highest-level variation is selected for automatic display.

15. A method as claimed in claim 8, characterised in that the output levels of the image variation data of the different camera positions are standardised so as to be mutually comparable, the standardised image variation levels of the different camera positions are compared, and the image data $(2d_1 - 2d_n)$ of the camera position representing the highest-level variation is selected for automatic display.

16. A method as claimed in claim 9, characterised in that the output levels of the image variation data of the different camera positions are standardised so as to be mutually comparable, the standardised image variation levels of the different camera positions are compared, and the image data ($2d_1$ - $2d_n$) of the camera position representing the highest-level variation is selected for automatic display.--

REMARKS

This Preliminary Amendment is submitted to change the multiple dependent claims to single dependent claims in order to reduce the government filing fee.

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Method for synchronising image data obtained from process monitoring cameras

The object of the invention is a method for synchronising image data obtained from process monitoring cameras, in which method

- different positions in the process are imaged using various cameras;
- image data from the different camera positions is stored per camera into digital image processors;
- images stored at the different camera positions are selected for display and analysis on the operator's computer screen; and
- from the image data obtained at the different camera positions are searched images depicting the same area in the web by using synchronisation means.

When the operator finds an interesting object among the images of a particular camera position, by utilising synchronisation he will be able to see the same area in the paper web when it passed other camera positions. This type of synchronisation has long been a characteristic of the Applicant's operations. However, its use involves certain problems or deficiencies. Due to the high speed and stretching of the web, it is not possible for the synchronisation to be so accurate as to necessarily show the corresponding area in the new position which the synchronisation produces. If there is, for example, an interruption at the dry end of the machine and the operator of the monitoring system searches for the same area in the web at the wet end of the machine, the operator cannot be absolutely certain whether the object is located in that area of the video recording displayed as a result of synchronisation, in which case the operator is likely to discontinue the search.

The aim of the present invention is to provide an improved synchronisation method, so that the operator will know for certain that he will arrive automatically in the middle of the visualised area, inside which the desired same area of the web can be found. The idea is, therefore, to compel the operator to go through an area of sequential images of a size that can be parametrised. In such a case, the corresponding area in the web in different camera positions will be found more reliably and easily.

The characteristic features of the method relating to the invention are presented in the appended claims 1 and 2. The dependent claims disclose preferred embodiments of the invention.

An exemplary embodiment of the invention is described in the following with reference to the accompanying drawings in which

Figure 1 shows the system used for implementing the synchronisation method relating to the invention as a flow chart, and

Figure 2 illustrates the performance of synchronisation on the basis of image data from different camera positions.

The general structure and operation of the system are first described before disclosing the manner according to the invention for visualising the area of sequential images to be synchronised to the operator.

In the flow chart shown in Figure 1, the image source is a video camera 1 which produces a continuous video image of the object being monitored. The image data is processed in a digital signal processor 2, or DSP processor. Signal processors are similar to ordinary microprocessors, but contain, among others, the use of floating-point number technology and address formats for easier addressing. Furthermore, the DSP is markedly different from the ordinary processor in terms of its architecture, having been designed for duties involving large amounts of data, and where multiplication with integers and data transfers are statistically significant operations. DSP processors are capable of performing a plurality of different and simultaneous calculation routines associated with image analysis, the results of which can be applied automatically to monitoring changes in image data.

The system comprises several video cameras 1 for imaging the various positions of the process being monitored. Each camera is provided with its own

digital image processor 2 for storing digital image data per camera. The signal processors 2 are used for analysing each camera-specific image data item so as to provide image variation data based on the level of variation in a plurality of sequential images. From the signal processors 2 the said image data and image variation data are transmitted to an analysing computer 15 which has a display 11.

The images stored at the different camera positions can be selected for analysis by means of selector icons 7. The image variation graph 8 corresponding to the image variation data of images preceding and following the image to be analysed is displayed at the bottom of the screen 11. A floating arrow designated by reference numeral 9 indicates the point on the image variation graph 8 at which the image 6 displayed is located. The floating arrow 9 can be used for selecting an image at any point on the graph 8 for display. The image data $2d_1$ - $2d_n$ stored from each camera position 1-n may encompass several hundred images. Depending on the process, the image data in store at each time may have a duration ranging from a few seconds to several minutes, and the storage may function on the FIFO (first in first out) principle.

Since each image variation graph 8 shown at the bottom of the screen 11 is prepared of image material from each camera position respectively, the image variation graphs of the different camera positions can be standardised so as to be comparable, and be compared with each other, whereby the image variation graph representing the highest-level variation and the image data of the camera position corresponding to it can be selected automatically for displaying on the analysing window of the screen 11. For the purpose of this automation, the system is provided with standardising means 3 for standardising the output levels of the image variation data of the different camera positions to be mutually comparable. A comparison between the standardised image variation levels of the different camera positions is performed by means of comparator means 4. Selector means 5 receive image data from the different camera positions and select, under the control of the comparator means 4, the image

data $2d_1$ - $2d_n$ representing the highest-level variation and the corresponding image variation graph 8 to be displayed on the screen 11. Image 6 is one of a multitude of images included in the image data. The graph 8 and the floating indicator 9 can be used for examining those very images 6 associated with the area of the highest-level image variation. The image 6 on the screen 11 may represent, for example, a hole formed in a paper web.

The automated selection of the image 6, as described above, is obviously optional, meaning that the operator may, if he so desires, select image data $2d_1$ - $2d_n$ from any camera position for analysis. However, it is often useful for the operator to know at the very beginning of analysis which camera position produced the highest-level image variation, in which case the analysis can be started from this particular camera position.

The operator's data processing means 15 comprise synchronisation means 12, 13, 14 by means of which images depicting the same area in the web can be sought automatically from the image data of different camera positions. When the synchronisation option 12 is displayed on the screen 11, the synchronisation unit 13 controls the image data selection unit 5 in such a way that the selection of a camera position by means of the selector icons 7 automatically produces on the screen 11 the image 6 which corresponds to the same area in the paper web as the image 6 of the previous camera position. For this purpose the synchronisation unit 13 requires certain parameters 14, which include at least web speed and the distances between the cameras 1. The synchronisation unit 13 is also given a time of occurrence 2t at which an interesting object was observed in the image field of a camera position, the web area corresponding to which having to be analysed from the different camera positions.

Figure 2 shows a hole, for example in the size press, in an image produced at point of time 2t in the image data $2d_n$ of camera n. On the basis of the time of occurrence and other parameter data, the synchronisation unit 13 is able to determine, by means of simple calculations, the images $2s_1$ - $2s_3$ in the image

data $2d_1$ - $2d_3$ in which the same hole appears. The accuracy of synchronisation cannot, however, be very high due to the high speed and stretching of the web, and thus in the invention is specified a marker 10, 10' of a certain width, which is visualised for the operator, within which the corresponding point in the web will be found with certainty. For the operator is thus visualised a selection area 10 in the environment of the point of synchronisation 9, 9' of each camera position, within which area there is a limited number of sequential images among which the corresponding point will be found with certainty. The said limited number is preferably a minimum number determined by the parameters such as web speed and distance between the camera positions. This marker area 10 motivates the operator to search for the corresponding point in the different camera positions. The size of the selection area 10, that is, the number of images contained by it is, therefore, dependent on web speed and the distances between the cameras.

Claims

1. A method for synchronising image data obtained from process monitoring cameras, in which method

- different positions in the process are imaged using various cameras (1);
- image data ($2d_1$ - $2d_n$) from the different camera positions is stored per camera into digital image processors (2);
- images stored at the different camera positions are selected for display and analysis on the operator's computer (15) screen (11), and
- from the image data ($2d_1$ - $2d_n$) obtained at the different camera positions are searched (2t, $2s_1$ - $2s_3$) images depicting the same area in the web by using synchronisation means (12, 13, 14),

characterised in that for the operator is visualised a selection area (10) corresponding to the limited number of sequential images in the environment of the point of synchronisation (9, 9') of each camera position

2. A method for synchronising image data obtained from process monitoring cameras, in which method

- different positions in the process are imaged using various cameras (1);
- image data ($2d_1$ - $2d_n$) from the different camera positions is stored per camera into digital image processors (2);
- images stored at the different camera positions are selected for display and analysis on the operator's computer (15) screen (11); and
- from the image data ($2d_1$ - $2d_n$) obtained at the different camera positions are searched (2t, $2s_1$ - $2s_3$) images depicting the same area in the web by using synchronisation means (12, 13, 14),

characterised in that for the operator is visualised a selection area (10, 10') representing the limited number of sequential images, the image ($2s_1$ - $2s_3$) inside the said area being brought to the screen (11) by the synchronisation means when the image on the screen moves from one camera position to another, the size of the selection area (10), that is, the number of images contained by it, being dependent on the speed of the paper web being

monitored and the distances between the cameras.

3. A method as claimed in claim 1 or 2, **characterised** in that the process is paper manufacture and the object being monitored is the paper web running in the paper machine.

4. A method as claimed in any of the claims 1 to 3, **characterised** in that camera-specific image data is analysed and image variation data based on the level of variation in a plurality of sequential images is compiled, and the image variation graph (8) corresponding to the image variation data of images preceding and following the image to be analysed is displayed on the screen (11).

5. A method as claimed in any of the claims 1 to 4, **characterised** in that the output levels of the image variation data of the different camera positions are standardised so as to be mutually comparable, the standardised image variation levels of the different camera positions are compared, and the image data ($2d_1$ - $2d_n$) of the camera position representing the highest-level variation is selected for automatic display.

(57) Abstract

The object of the invention is a method for synchronising image data obtained from process monitoring cameras. By utilising synchronisation, one and the same area in a paper web can be sought as it passed the different camera positions. Since the speeds are high and the webs somewhat stretching, synchronisation does not often directly result in the same area being shown in the different camera positions. To facilitate searching, a selection area (10) corresponding to the limited number of sequential images in the environment of the point of synchronisation (9, 9') of each camera position is visualised for the operator, inside which area the corresponding area in the web can be found with certainty

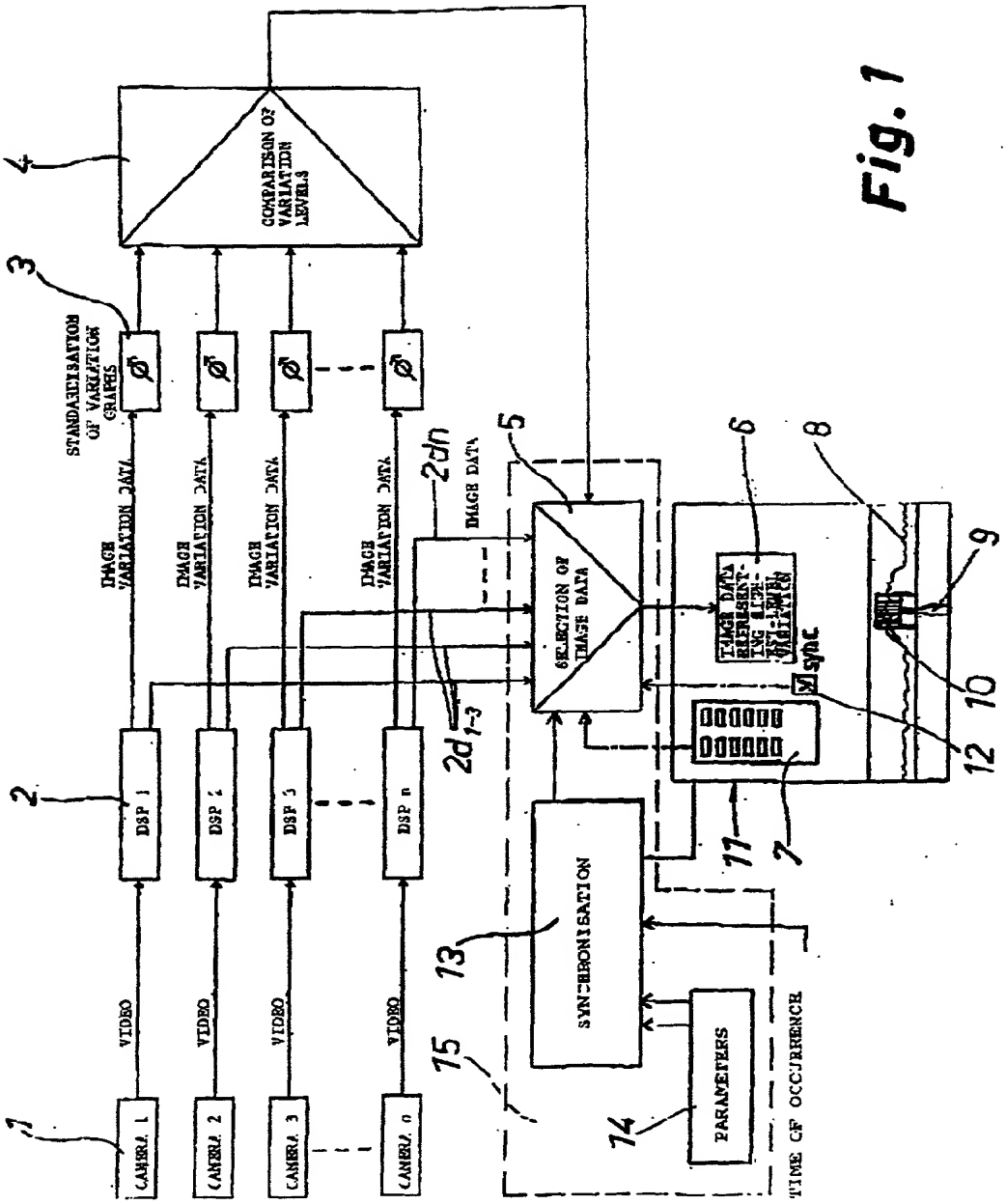
4
COMPARISON OF VARIATION LEVELS
3
STANDARDISATION OF VARIATION CURVES
IMAGE VARIATION DATA
2dn
IMAGE DATA
5
6
8
9
SELECTION OF IMAGE DATA
IMAGE DATA REPRESENTING THE SIZE OF VARIATION
sync
10
12
2d1-3
2
DSP 1
DSP 2
DSP 3
DSP n
11
7
13
SYNCHRONISATION
VIDEO
1
CAMERA 1
CAMERA 2
CAMERA 3
CAMERA n
15
14
PARAMETERS
TIME OF OCCURRENCE

Fig. 1

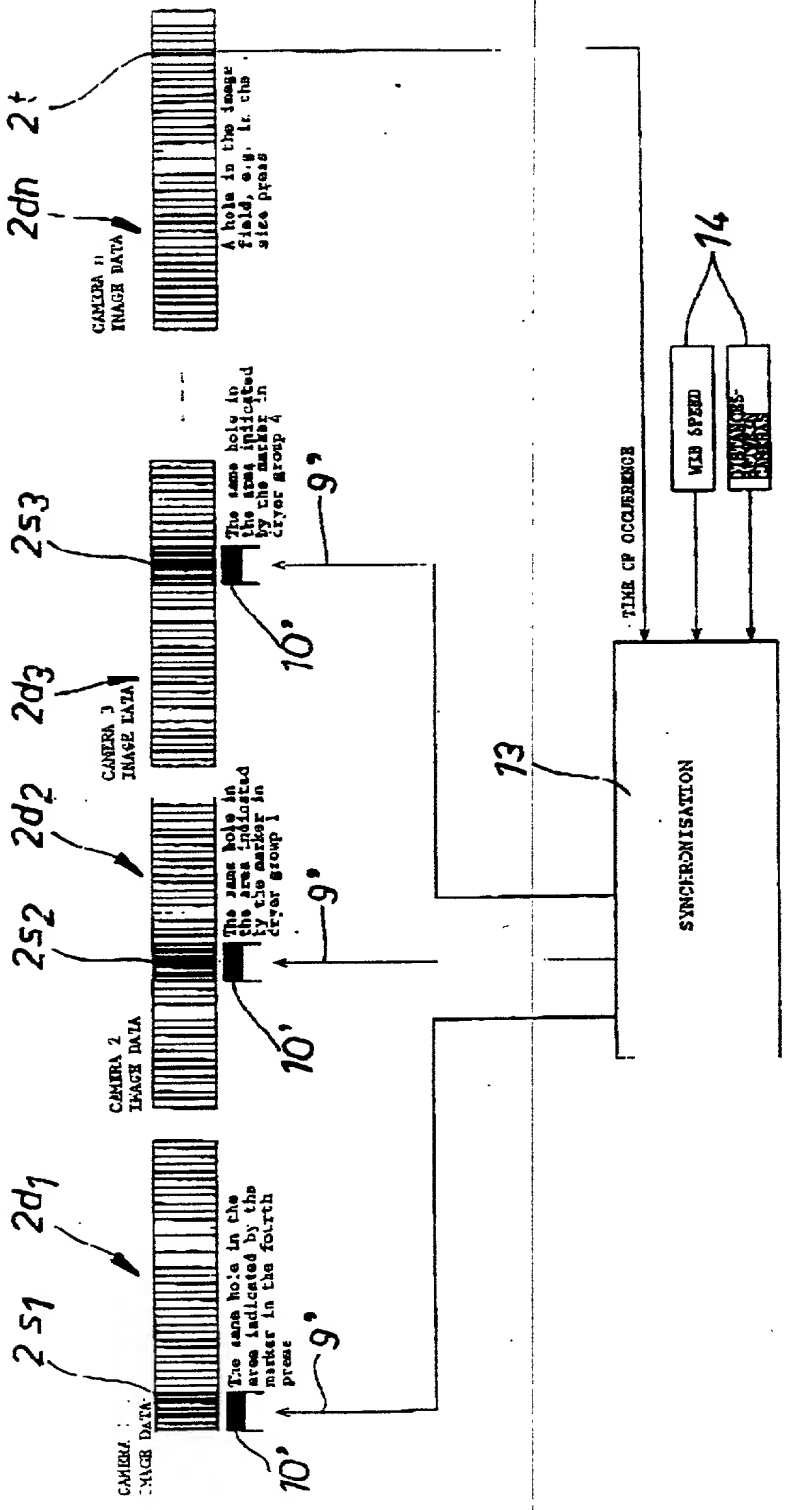
2t
2dn
CAMERA n IMAGE DATA
A hole in the image field, e.g. in the size press
2s3
2d3
CAMERA 3 IMAGE DATA
The same hole in the area indicated by the marker in dryer group 4
9'
10'
2s2
2d2
CAMERA 2 IMAGE DATA
The same hole in the area indicated by the marker in dryer group 1
2s1
2d1
The same hole in the area indicated by the marker in the fourth press
13
FIRE OR OCCURRENCE
WEB SPEED
14
SYNCHRONISATION

Fig. 2

UNITED STATES OF AMERICA COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION	OFGS FILE NO. P/1805-15

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that I verily believe that I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Method for synchronising image data obtained from process monitoring cameras

the specification of which is attached hereto, unless the following box is checked:

☐ was filed on _____ as United States patent Application Number or PCT International patent application number _____ and was amended on _____ (if any).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information known to be material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim priority benefits under Title 35, United States Code §119 of any foreign application(s) for patent or inventor's certificate or United States provisional application(s) listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign or Provisional Application(s)

COUNTRY	APPLICATION NUMBER	DATE OF FILING *(day, month, year)*	PRIORITY CLAIMED UNDER 35 U.S.C. 119
Finland	990428	01.03.1999	YES X NO ___
			YES ___ NO ___
			YES ___ NO ___

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

UNITED STATES APPLICATION NUMBER	DATE OF FILING *(day, month, year)*	STATUS *(patented, pending, abandoned)*

I hereby appoint customer no. 2352 OSTROLENK, FABER, GERB & SOFFEN, LLP, and the members of the firm, Samuel H. Weiner - Reg. No. 18,510; Jerome M. Berliner - Reg. No. 18,653; Robert C. Faber - Reg. No. 24,322; Edward A. Meilman - Reg. No. 24,735; Stanley H. Lieberstein - Reg. No. 22,400; Steven I. Weisburd - Reg. No. 27,409; Max Moskowitz - Reg. No. 30,576; Stephen A. Soffen - Reg. No. 31,063; James A. Finder - Reg. No. 30,173; William O. Gray, III - Reg. No. 30,944; Louis C. Dujmich - Reg. No. 30,625 and Douglas A. Miro - Reg. No. 31,643, as attorneys with full power of substitution and revocation to prosecute this application, to transact all business in the Patent & Trademark Office connected therewith and to receive all correspondence.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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